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(54) Ink jet needle humidor sealing system.

(57) A sealing apparatus or humidor (50 ; 200) selectively seals an orifice (80) of a hollow ink needle (75) used to transport ink (45) from a reservoir (40 ; 40') to a printhead (30 ; 30') of an inkjet printing mechanism (20). The humidor (50) has a resilient elastomeric body (52) that forms a needle parking core (82 ; 202) where the body (52) extrudes into the needle orifice (80) to form a pseudopod plug (88) that seals the orifice (80). Alternatively, the humidor body (202) is a foam material surrounded by a substantially moisture impervious skin (205) that defines a humidically isolating parking core. Inserting the needle (75) through the humidor (50 ; 200) pierces the body (52, 202) to either extract ink (45) from the reservoir (40 ; 40') or infuse ink (45) into the printhead (30 : 30'). During refilling, or replacement of the reservoir or printhead (40,40' ; 30,30'), the needle (75) is retracted into the humidor (50 ; 200) until the orifice (80) is surrounded by the parking core (82 ; 202). The humidor body (52 ; 202) humidically isolates the needle orifice (80), which virtually eliminates ink spills, drying or contamination of the ink (45) within the needle (75), and prevents operator injury by the needle tip (78).

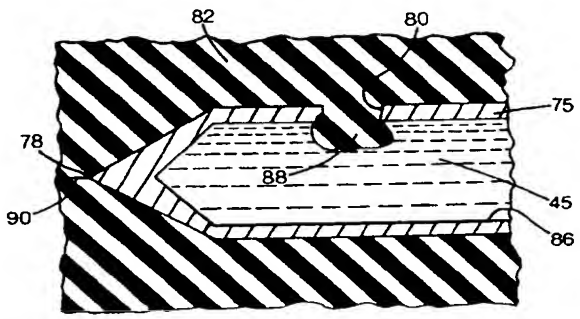

FIG. 9

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Related Application

This is a continuation-in-part application of the co-pending U.S. patent application serial no. 08/223,268, filed on April 4, 1994, both having the same inventor.

Field of the Invention

This invention relates generally to an inkjet printing mechanism, and more particularly to a sealing apparatus and method for selectively sealing an ink needle used to transport ink from a reservoir to a printhead of such a mechanism, which may be used, for instance, in an inkjet printer, plotter, facsimile machine or other inkjet printing device.

Background of the Invention

Inkjet printing mechanisms use pens which shoot drops of ink onto a page or sheet of a print medium. Each pen has a printhead formed with very small nozzles through which the ink drops are fired. To print an image, the printhead moves back and forth across the page shooting ink drops as it moves. Inkjet printing mechanisms may be included in a variety of different devices, such as inkjet printers, plotters, scanners, facsimile machines, or other devices, all of which are referred to collectively herein as "inkjet printers." The print medium is typically a sheet material, such as paper, mylar, foils, transparencies, card stock, etc., but for convenience the term "paper" is used herein for purposes of illustration.

In the past, some inkjet pens were formed as cartridges which carried their own reservoir of ink back and forth across the page during printing. Printers using this type of inkjet cartridge are often referred to as "cartridge-type" printers. A new generation of inkjet printers, known as "off-axis" printers, has been proposed. In the off-axis printers, only the printhead moves across the page, and ink is delivered to the printhead from a stationary reservoir. Typically, the reservoir is mounted to the printer chassis, and is designed to be replaced or refilled when empty. Off-axis printers may be equipped either with a single printhead for monochromatic printing, or with several printheads for color printing. Ink is typically delivered from the stationary reservoir to the printhead through a flexible conduit or tube. Of course, for color printing, several reservoirs and associated conduits are required, with one set used for each color.

In these off-axis ink delivery systems, one point of interest is the interface of the ink delivery tube with the printhead and with the reservoir. At these interfaces, the tubing may be permanently attached. In other implementations, the tubing may terminate in a chromatography-type needle for piercing a rubber septum sealing the reservoir and/or printhead. For example, one such interface arrangement is shown in FIGS. 18A-18B, which are perspective views showing different stages of use. FIG. 18A shows a stationary ink reservoir R_1 sealed by a septum S_1, and a flexible tubing T attached to an ink transport needle N. FIG. 18B shows the system after the needle N has pierced the septum S_1 to extract ink from the reservoir. This needle/septum assembly may be used to control the flow of ink through the needle and tubing to the printhead, in a manner comparable to that of a mechanical valve. When the reservoir R_1 needs refilling or replacement, the needle N is withdrawn to stop ink flow, with the septum S_1 remaining mounted to the reservoir R_1, as shown in FIG. 18A.

Unfortunately, after retraction from the reservoir R_1 as shown in FIG. 18A, the needle N is then exposed to the environment and subject to physical damage. In this condition, the ink within the needle is subject to contamination, and may eventually dry out causing clogging of the needle N. The ink can also leak from the retracted needle, which may lead to unnecessary staining or other damage. Furthermore, when retracted, the needle N can become filled with air. This entrapped air is eventually expelled from the printhead, instead of an ink droplet, resulting in the printing of an incomplete image, or worse yet, resulting in permanent damage to the printhead. To eliminate air from the ink tubing T after periods of inactivity, some systems purge the tubing at start-up to remove air bubbles and replace any dried or contaminated ink with fresh ink. This purging is a very costly procedure, which for some lower-volume users may waste an entire month's supply of ink.

Referring to FIGS. 19A-19C, a conventional mechanical humidity chamber design is shown, with FIG. 19A being a perspective view, and FIGS. 19B-19C being elevational sectional views of the FIG. 19A chamber of mounted in a reservoir, showing different stages of use. In this system, two septa S_2 and S_3 are housed within a plastic casing C which defines a humidity chamber H. FIGS. 19A and 19B show the needle N inserted through both septa S_2 and S_3 in a position to extract liquid from reservoir R_2. For refilling the reservoir R_2, rather than withdrawing the needle from both septa, the needle is only retracted from the interior septum S_3, as shown in FIG. 19C.

While the humidity chamber H formed by intermediary casing C provides a gas-tight and liquid-tight seal around the needle N, this design suffers several disadvantages. For example, this humidity chamber seal requires many parts, which must be separately ordered, inventoried and assembled. Furthermore, to maintain a gas-tight seal, the tolerances for the casing C, the septa S_2, S_3 and reservoir R_2 are very high. Additionally, the force required to insert and retract the needle N through both septa S_2, S_3 is quite high, due to the frictional forces imposed by each septum against the needle N.

Thus, the earlier prior art systems for sealing an ink transport needle have failed to adequately address the problems of ink leakage, ink degradation through drying or contamination, and needle damage or clogging. Clearly, some easy, cost effective manner of protecting the retracted needle is needed to retain the ink chemistry and volume, while also preventing ink leakage.

Summary of the Invention

According to one aspect of the present invention, a sealing apparatus is provided for sealing an orifice of an ink needle supported to transport ink between delivery points in an ink jet printing mechanism. The sealing apparatus includes a humidically isolating portion having opposing entry and exit ends, and a biasing portion. The biasing portion couples the isolating portion to a needle support adjacent one of the delivery points to selectively seal and expose the needle orifice.

In an illustrated embodiment of the present invention, the humidically isolating portion comprises a resilient body defining a needle receiving cavity extending inwardly from the entry end and terminating in a first wall. The body defines a needle sealing portion between the first wall and the exit end. The body also has an outer surface defining a mounting portion. The apparatus also has a bias support member that couples the body mounting portion to the biasing portion, which may be a spring member.

According to another aspect of the present invention, the sealing apparatus comprises a body of a foamed material surrounded by a skin of a substantially moisture impervious material to define opposing needle entry and exit ends with a humidically isolating portion therebetween.

According to other aspects of the present invention, methods are provided of sealing an orifice of a hollow ink needle used to transport ink between delivery points in an inkjet printing mechanism. These methods may be implemented using the sealing apparatuses described above.

According to further aspects of the present invention, an ink jet printing mechanism is provided which may include the sealing apparatuses described above.

An overall goal of the present invention is to provide an inkjet printing mechanism and a method of extracting ink from a stationary reservoir and delivering it to a moving printhead, which allows the reservoir to be periodically refilled, and the printhead to be replaced without damaging or contaminating the ink needle.

Another goal of the present invention is to provide an ink reservoir and/or a printhead sealing system which minimizes ink spills, clots, and contamination during exchange of the printhead or reservoir, or during refilling of the reservoir.

A further goal of the present invention is to provide an ink reservoir and/or a printhead sealing system which requires relatively low ink needle insertion and extraction forces to provide a more compact inkjet printing mechanism.

Brief Description of the Drawings

FIG. 1 is a perspective view of an inkjet printing mechanism showing a first embodiment of an inkjet needle humidor sealing system of the present invention.

FIGS. 2 and 3 are two perspective enlarged views of opposite ends of the humidor of FIG. 1.

FIG. 4 is an enlarged elevational sectional view of a portion of the reservoir of FIG. 1, showing one manner of installing the humidor.

FIG. 5 is an enlarged axial sectional view taken along lines 5--5 of FIG. 3.

FIGS. 6-8 are enlarged elevational sectional views of the humidor and a portion of the reservoir of FIG. 1, showing various stages of use.

FIG. 9 is an enlarged axial sectional view of a portion of the humidor of FIG. 1.

FIG. 10 is a partially schematic sectional view of an alternate manner of installing the humidor of FIG. 1.

FIGS. 11 and 12 are enlarged elevational sectional views of a portion of the reservoir of FIG. 10 showing another manner of installing the first embodiment of the humidor, and illustrating various stages of use.

FIG. 13 is a perspective view of a second embodiment of an inkjet needle humidor of the present invention.

FIGS. 14 and 15 are enlarged elevational sectional views of the humidor of FIG. 13 shown mounted in a portion of an inkjet printing mechanism reservoir to illustrate various stages of use.

FIGS. 16 and 17 are enlarged elevational sectional views of the humidor of FIG. 13 showing another manner of installation, and illustrating various stages of use.

FIGS. 18A and 18B are perspective views of a prior art ink needle and reservoir system illustrating various stages of use.

FIG. 19A is a perspective view of a second prior art mechanical humidity chamber having two septa.

FIGS. 19B and 19C are elevational sectional views of the prior art humidity chamber of FIG. 1 9A mounted in a reservoir to illustrate various stages of use.

Detailed Description of a Preferred Embodiment

FIG. 1 illustrates an embodiment of an inkjet printing mechanism, here shown as an inkjet printer 20, constructed in accordance with the present inven-

tion, which may be used for printing for business reports, correspondence, desktop publishing, and the like, in an industrial, office, home or other setting. Other inkjet printing mechanisms may embody the present invention, such as plotters, portable printing units, and facsimile machines, to name a few, but for convenience the concepts of the present invention are illustrated in the environment of an inkjet printer 20.

While it is apparent that the printer components may vary from model to model, the typical inkjet printer 20 includes a chassis 22 and a print medium handling system 24 for supplying a print medium to the printer 20. The print medium may be any type of suitable sheet material, such as sheets of paper, cardstock, foils, mylar, transparencies, and the like, but for convenience, the illustrated embodiment is described using paper as the print medium. The print medium handling system 24 includes a drive motor and a series of rollers (not shown) for delivering the sheets from a feed tray 26, into a print zone 25, and then into an output tray 28.

A printhead and carriage assembly 30 is driven from side to side across the print zone 25 along a guide rod 32 by, for example, by a conventional drive belt/pulley and motor assembly (not shown). The printhead 30 has a bottom surface comprising an orifice plate (not shown) with a plurality of nozzles therethrough which may be formed in a manner well known to those skilled in the art. Typically, the printhead 30 is a thermal inkjet printhead, although other types of printheads may be used, such as piezoelectric printheads. The printhead 30 typically has a plurality of resistors (not shown) which are associated with the nozzles. Upon energizing a selected resistor, a bubble of ink is formed and then ejected from the nozzle on to a portion of the sheet located in the print zone 25 adjacent the nozzle.

The printhead 30 selectively deposits one or more ink droplets on the print medium in accordance with instructions received via a conductor strip 34 from a printer controller 36, such as a microprocessor located within the chassis 22, for instance at the location shown in FIG. 1. The controller 36 also instructs the drive motor (not shown) of the print medium handling system 24 to advance the sheet media through the print zone 25. The controller 36 generally receives instructions from a computer (not shown), such as a personal computer. Personal computers, their input devices, such as a keyboard and/or a mouse device (not shown), and computer monitors are all well known to those skilled in the art.

A fluid colorant, referred to herein generally as "ink," is delivered to the printhead 30 from a supply stored in a reservoir 40 via an ink conduit or tubing system 42. As the printhead 30 is propelled back and forth across print zone 25, it is apparent that the conduit 42 must flex and bend as the printhead end moves with the printhead relative to the stationary end at reservoir 40. The conduit 42 may be constructed in a conventional manner from a variety of different elastomers and plastics, known to those skilled in the art. The reservoir 40, conduit 42, and printhead 30 may be monochromatic, for printing in a single color, black for instance, or multi-color, for printing combinations for cyan, magenta, yellow, and possibly true black (as opposed to composite black printed from a combination of cyan, magenta and yellow). For convenience, a black ink monochromatic embodiment of printer 20 will be used to illustrate the present invention.

A variety of different systems may be implemented to propel the ink from the reservoir 40 to the printhead 30. For example, a piston actuator assembly 44 may extend into the reservoir 40 to force ink into the conduit 42. Other methods of urging the ink through conduit 42 include the use of capillary action, a gravity feed system provided by mounting the reservoir 40 at a location (not shown) which is higher than the printhead 30, or through pumping action, for instance provided by a peristaltic pump (not shown).

First Humidor Sealing System Embodiment

Referring also to FIGS. 2-4, it is apparent that during use, a supply of ink 45 within the reservoir 40 will eventually become depleted, and require either refilling (FIG. 4) or installation of a replacement reservoir (FIG. 10, described further below). In the illustrated manner of interfacing the conduit 42 with reservoir 40 for refilling, a wall 46 of the reservoir 40 has an outlet port or orifice 48 therethrough which may be sealed using a sealing apparatus, such as a humidor 50, constructed in accordance with the present invention. The illustrated humidor 50 comprises a body 52 which has an outer surface 54, shown as being generally cylindrical in shape to define a longitudinal axis 55. A humidor 50 may also be used to connect the conduit 42 to the printhead 30 in a like manner, but for the sake of brevity, only the coupling of humidor 50 to the reservoir is described to illustrate the concept.

The body 52 is preferably constructed of a single resilient material, such as an elastomeric material, for instance, a silicone elastomer or, more preferably an EDPM elastomer. While the selected material and durometer of the body 52 may vary for different implementations, preferably, the durometer is between 30 and 70, with a more preferred range of the durometer being 30 to 50. More particularly, the preferred durometer for an EDPM elastomer body 52 is a nominal value of 45 plus or minus typical manufacturing tolerances, on the order of +/- 5.

While the humidor 50 is illustrated as being cylindrical in shape, it is apparent that other cross sectional shapes, such as rectangular, oval, or other polygonal shapes may be used; however, the circular cyl-

indrical shape is preferred for ease of assembly and minimization of the elastic material required to construct body 52. In the illustrated embodiment, the humidor body 52 includes a base portion 56, a neck portion 58, and a head portion 60. The cylindrical base 56 is bounded by a surface defining an external or entry end 62, and by an annular outboard sealing surface 64. The cylindrical head 60 is bounded by bounded by a surface defining an internal or exit end 66, and by an annular inboard sealing surface 68.

Referring to FIG. 4, the base 56 and head 60 are illustrated as having equal diameters D_1 which facilitates ease of manufacture and storage, although it is apparent that the diameters of the head 60 and base 56 may also differ. The diameter of neck 58 is shown as D_2, which is less than the diameter D_1 of the head 60 and base 56. The neck diameter D_2 is sized to be received by the reservoir outlet port 48. The axial length of neck 58 is approximately equal to the thickness T_1 of the wall 46. The outboard and inboard sealing surfaces 64 and 68 grip the respective outboard and inboard surfaces of the reservoir wall 46. By selecting the relative diameters D_1 and D_2, and the axial length of the neck 58 in this manner, the head 60, neck 58 and base 56 form a liquid and gas impervious seal at the reservoir outlet port 48.

The area of reduced cross section D_2 provided by the neck 58 advantageously functions as a retaining surface, which allows the humidor 50 to be either clamped or press-fit into the reservoir orifice 48. Furthermore, the axial length L_1 of the head 60 may be selected to be less than the axial length L_2 of the base 56 to assist in easily assembling the humidor 50 within the reservoir port 48. That is, the longer length of the base portion 56 provides a larger gripping surface for manually inserting the head portion 60 through port 48 during installation. The longer base 56 also assists in readily distinguishing the humidor external end 62 from the internal end 66

With reference to FIGS. 5 and 6, the humidor body 52 defines a needle receiving cavity 70 which extends inwardly from the entry end surface 62 to terminate in a cavity first wall 72. The cavity 70 is also defined by a preferably cylindrical wall 74. The needle cavity 70 has a diameter D_3, which is preferably substantially equal to the diameter of a hollow needle 75. The needle 75 may be a chromatography-type needle of a conventional design, as shown in FIG. 6, a medical hypodermic tip needle design, or other fluid transmitting needle design. The conduit 42 is coupled to a tail end 76 of the needle. The needle 75 also includes a tip 78 which has an orifice 80 therethrough, so ink may flow through the hollow trunk of the needle and through the interior of conduit 42.

Referring also to FIGS. 7 and 8, a preferred manner of sealing the reservoir 40 and extracting ink from the reservoir for delivery to the printhead 30, in accordance with the present invention, is illustrated. Beginning from an initial insertion position shown in FIG. 6, the needle 75 is then forced through a sealing portion or parking core 82 (see FIG. 5) of the humidor 50. The parking core 82 is located substantially along the axis 55 between the cavity first wall 72 and the exit end surface 66. In FIG. 7, the needle 75 has pierced the parking core 82 and exit surface 66, and is engaged with the humidor 50 to extract ink from reservoir 40. In this ink extraction position, the needle orifice 80 is exposed to the interior of reservoir 40 to draw ink 45 into the needle.

Upon depletion of the reservoir 40, it is desirable to isolate the needle 75 from contact with the environment, and from becoming filled with air, which could deprime the conduit 42 and the printhead 30. Also, exposure of the ink 45 within the needle 75 and conduit 42 to air may cause degradation of the chemistry of ink within the needle and conduit. Indeed, excessive exposure to the air may even cause the ink 45 to dry out and clog these passage ways. Moreover, it is also desirable to protect the needle from damage, as well as guarding the tip orifice 80 from becoming clogged or contaminated during refilling or replacement of reservoir 40.

Referring to FIG. 8, a method of sealing the tip orifice 80 of needle 75 during reservoir refilling or replacement is illustrated. From the ink extracting position shown in FIG. 7, the needle 75 is withdrawn into the humidor body 52, until the tip's orifice 80 lies within the needle's parking core 82. For example, by selecting the relative proportions of the needle 75 and humidor 50 to be in the order of those shown in FIG. 8 for instance, with the needle tip 78 retracted into the body 52, just below the exit surface 66, the orifice 80 is parked within the sealing core 82. When parked in the rest position of FIG. 8, the elastomer material of the humidor body 52 caps the needle orifice 80.

FIG. 9 illustrates in greater detail the operation of the humidor 50 when the needle is parked at rest, as well as best showing the hollow interior chamber 86 of needle 75. The resilient material of body 50, when selected as described above, forms a temporary ink hole plug, also referred to herein an "elastomer pseudopod" (literally, "false-foot") 88. When the needle is parked, the pseudopod 88 extrudes into the needle orifice 80, filling and sealing the orifice 80 to isolate the ink 45 within the needle 75 from the external environment. Effectively, the elastomer pseudopod 88 "grows" from the humidor body 52 to plug the needle orifice 80. It is apparent that, while only a single needle orifice is shown, the humidor 50 may easily accommodate and seal a multi-orifice needle (not shown), as well as a hypodermic needle or various other types of needles.

Other needle seals are also formed by the humidor 50, one being along the trunk of the needle provided by the cylindrical wall 74 of the cavity 70. When the head portion 60 is pierced by needle 75 (FIG. 7), a

passageway or channel 90 is formed through the head 60. Another seal is formed when the head portion 60 resiliently closes upon the needle's self-formed channel 90, so the needle 75 is isolated from the environment adjacent the exit end surface 66. Upon reinsertion of the needle 75 into the reservoir 40, after refilling for instance, the needle 75 will likely follow substantially the same channel 90. If instead during reinsertion, the needle 75 forms a new channel (not shown) adjacent to channel 90, then the resilient body 52 also seals the initial channel 90.

Several advantages are realized using the humidor 50. For example, humidor 50 preferably consists of only one part. This is particularly advantageous in inventory tracking and manufacturing because fewer parts are required to construct the inkjet printer 20. Also, due to the self-sealing nature of its elastomeric construction, humidor 50 does not require additional seals or septa, as required in the prior art mechanical humidity chamber of FIGS. 19A-19C.

Furthermore, the needle 75 is easier to insert through humidor 50, than through the earlier humidity chamber of FIGS. 19A-19C. Since the humidor precast needle cavity 70 is sized to substantially equal the outer diameter D_3 of needle 75, the needle encounters only minimal frictional forces from contact with the cavity wall 74 as it slides through cavity 70. Thus, the main frictional forces encountered during insertion and retraction of needle 75 are those generated when moving through parking core 82. Indeed, the frictional forces on needle 75 are not appreciably higher than the forces encountered in the prior art system of FIGS. 18A and 18B, where the needle N pierces only a single septum S_1. Thus, needle 75 encounters less frictional forces when inserted through humidor 50, than a needle inserted through a traditional two septum humidity chamber, as shown in FIGS. 19A-19C.

It is apparent that the principles for using the needle and humidor interface, as described above with respect to FIGS. 6-9 for sealing the reservoir 40, may also be applied to sealing the interface of the conduit 42 and the printhead 30, as shown in FIG. 1. Thus, the printhead 30 may be replaced by parking the needle 75, as shown in FIG. 8, removing the humidor 50 from the old printhead, and inserting the humidor in a new printhead. While it is apparent that a similar replacement method could be accomplished at the reservoir, inserting the humidor into the new reservoir wall could be an extremely messy task. Instead, a preferred manner of reservoir replacement, which may also be used when replacing the printhead, is illustrated in FIG. 10.

Referring now to FIG. 10, an alternate preferred embodiment of an ink transport system 100 is shown separate from the other components of printer 20. The ink transport system 100 is particularly suitable for replacing reservoir 40' and printhead 30', although refilling of the reservoir 40' may also be accomplished using system 100. The illustrated reservoir 40' has a wall 102 which defines an outlet port 104 therethrough. The reservoir port 104 may be sealed by a conventional septum 105. The printhead 30' has a wall 106 that defines an inlet port 108 therethrough which is in fluid communication with the printhead nozzles (not shown). The port 108 may be sealed by a conventional septum 110.

Adjacent the reservoir 40', a humidor mounting member 112 may be secured to the printer chassis or to the reservoir wall 102 to grip throat 58 of the humidor 50 and place the surface of the exit end 66 adjacent the septum 105. A printhead humidor mounting member 114 may be secured (not shown) to the printhead wall 106 or another portion of the printhead carriage assembly 30'. The mounting member 114 is located to grip throat 58 of the humidor 50 and position the exit end surface 66 adjacent the printhead septum 110.

In the transport system 100, each end of conduit 42 terminates in an ink needle 75. The needles 75 extend through humidors 50 to pierce the septa 105 and 110 of the respective reservoir 40' and printhead 30' to deliver ink from the reservoir to the printhead. Indeed, in a broad sense, the combination of the humidor 50 and needle 75 may be considered as an interfacing assembly for mating or selectively fluidicly coupling the conduit 42 with either the reservoir 40, 40' or the printhead 30, 30'. The needles 75 may be manually inserted and retracted (as illustrated in FIGS. 7 and 8, for instance), or a controllable needle actuator device (not shown) may be used to automate operation of the printer 20.

FIGS. 11 and 12 illustrate a portion of an alternate ink transport system 150 constructed accordance with the present invention showing another manner of linking the ink tubing 42 and needle 75 with an ink reservoir 40'. A similar linking system may be used to couple the tubing 42 to a printhead 30' (FIG. 10), but for simplicity only the coupling at reservoir 40' is illustrated. It is apparent that combinations of the various mounting methods may be used as required, for instance using the installation system of FIG. 4 with that of FIG. 11 in a single printing mechanism. While FIGS. 5-8 contemplate a fixed reservoir 40 and a moving or reciprocating needle 75, it is apparent that relative motion between the needle and reservoir is required for insertion and extraction of the needle. FIGS. 11 and 12 illustrate the concept of needle 75 being supported by a needle mounting member or support 152 which may be secured to the printer chassis 22, or to the printhead carriage assembly 30, 30'.

The transport system 150 has an interface or linking portion 153 that includes a collar member 154 which surrounds humidor 50, preferably around the neck portion 58. A biasing portion, such as a resilient

biasing member, shown here as compression spring member 155, couples the humidor 50 using humidor collar 154 to the needle support 152. Thus, the spring 50 locates the needle isolating or sealing portion 82 adjacent one of the system delivery points, here adjacent the reservoir 40.

FIGS. 11 and 12 illustrate the parked and ink-delivery positions of needle 75, with the spring 155 transitioned between unbiased and biased states to selectively seal and expose the needle orifice 80. In FIG. 11, the needle 75 is parked with the reservoir 40' positioned either prior to linking, or after extraction of needle 75. In FIG. 12, the reservoir 40' is positioned for normal ink transporting operation with the spring 155 in a compressed state. When the spring 155 is compressed, the needle 75, which is secured in the mounting support 152, pierces the humidor exit surface 66, and the septum 105 of reservoir 40'. To cover the needle tip 78 upon removal of reservoir 40', the spring 155 expands to force the humidor 50 away from the mounting member 152 until the tip 78 lies within the sealing portion 82, as shown in FIG. 11.

Several additional advantages are realized using the humidor 50. For example, by sealing the needle orifice 80 through the formation of pseudopods 88, the ink 45 inside the needle is isolated from the outside printer environment. In this manner, the humidor 50 also maintains the humidity of the ink 45 within the needle and conduit 42. Also, by providing a positive seal, the humidor 50 assists in preventing ink drips and spills in two ways. First, the self-sealing exit end surface 66 and needle cavity 70 act as valve-like barriers to prevent ink 45 from flowing onto an operator through casual contact with the needle 75. Second, the elastomer pseudopods 88 act as valves to shut off ink flow from the needle 75, and thus assist in preventing large ink spills.

While the illustrated embodiment of humidor 50 has been shown in use at the interfaces of the conduit 42 with the reservoir 40, 40' and printhead 30, 30', it is apparent that a similar needle and humidor interface system may also be useful at other locations, such as when coupling a backup auxiliary reservoir (not shown) to the main reservoir 40. And finally, while the humidor 50 is illustrated as being an integral unitary part constructed of a single elastomer, it is apparent to those skilled in the art that for some implementations a combination of elastomers may be more suitable, provided they are joined together to form a liquid and gas impervious seal. For instance, it may prove advantageous to provide a humidor 50 with the base 56 being of a higher durometer material, while the neck and head portions 58, 60, including parking core 82, are of a lower durometer to facilitate forming the pseudopods 88 and resiliently sealing the reservoir port 48.

Second Humidor Sealing System Embodiment

FIG. 13 illustrates a second embodiment of a sealing apparatus as an elastomer-skinned foam needle humidor 200 constructed in accordance with the present invention. FIGS. 14 and 15 illustrate a portion of an alternate ink transport system 201 constructed accordance with the present invention to link the ink tubing 42 and needle 75 with ink reservoir 40. It is apparent that a similar linking system may be used to couple the tubing 42 to a printhead 30 (FIG. 1), but for simplicity only the coupling at the reservoir 40 is illustrated. The humidor 200 is installed in the outlet port 48 of reservoir wall 46, where the needle 75 moves by translational motion into engagement with the humidor 200. This translational movement may be provided manually, or through automation (not shown) provided by the inkjet printing mechanism 20. In FIG. 14, the needle 75 is sealed in a parked position as described further below, whereas FIG. 15 illustrates the needle 75 in a normal position to extract ink 45 from reservoir 40. As mentioned above with respect to humidor 50, the humidor 200 may also be used to couple the conduit 42 to the printhead 30 in a similar manner, but only the coupling to the reservoir 40 is illustrated for the sake of brevity.

It has been found that in some implementations the humidor 50 (FIGS. 1-12) requires a rather large amount of force to move needle 75 through the humidor. The required insertion and extraction forces are required to overcome the rather high frictional forces that may be developed as the elastomeric material of body 52 grips the surface of needle 75 during relative movement of the needle 75 through the body 52. These frictional forces may be attributed both to forming channel 90, and to moving needle 75 through the receiving cavity 70. These high frictional forces may require that the components used to insert needle 75 through humidor 50 be of a stronger construction, or if inserted by an operator, that more force be applied by the operator.

To reduce the frictional force of the body material against the surface of needle 75, the humidor 200 has a soft resilient body 202, preferably of a porous resilient material, such as a spongy synthetic foam, a foam rubber material, a closed cell foam, or more preferably, a polyurethane reticulated foam, such as may be obtained from Foamex Corp., located in Eddystone, Pennsylvania. Reticulated foam is formed as a closed-cell foam that is then reticulated to blow open the cell walls to provide capillary paths through which the ink is drawn by capillary action. Preferably, the foam material is compatible with the ink, and has a firmness or "felting ratio" which allows the body 202 to be easily pierced by needle 75, so the needle cavity 70 of humidor 50 may be eliminated. The term "felting" is used to describe the permanent plastic set imparted to the foam under heat and pressure.

The foam body 202 has an outer surface 204 that is preferably surrounded by or encased within a fluidic barrier shell or skin 205, which lessens the rate at which ink 45 loses water or other volatile fluid components. The skin 205 has an inner surface 206, which preferably lies adjacent the body outer surface 204, and an outer surface 208. Preferably the skin 205 is of a resilient elastomeric material, such as a silicone elastomer, or more preferably an EDPM elastomer, although various plastics may also be used. The skin or casing 205 may be of varying materials or durometers depending upon the particular implementation, but preferably the Shore A durometer is between 30 and 70, with the more preferred range of durometer being 30 to 50. For example, a preferred EDPM elastomer body 205, a nominal durometer of 45 plus or minus typical manufacturing tolerances, on the order of plus or minus five, is preferred.

Preferably, the body 200 is formed with a plurality of chambers to trap any ink escaping through the needle orifice 80. When these chambers are not all interlinked; as in a closed cell foam material, the body material in the immediate region adjacent the needle orifice 80 forms a humidically isolating portion of humidor 200. Any ink 45 which may have leaked into the chambers during earlier parkings or insertions of the needle also serves to maintain the humidified atmosphere if still moist. If previously leaked ink has dried in the humidor, it serves to isolate the region adjacent the orifice and/or decrease the volume available for air within the humidor. The skin 205 assists in maintaining a humidified environment for the needle orifice 80 by isolating the body outer surface 204 from the air. The skin 205 also assists in preventing ink leakage through any passageways which may form through a closed cell foam body 202. Optionally, the skin 205 may also be treated to enhance its vapor barrier characteristics. One such treatment process known to those skilled in the art is sulfonation, but it is apparent that other processes may be used.

When the chambers of the body material are substantially all interlinked, as in a sponge-like material, the skin 205 plays a greater role in maintaining a humidified environment for the needle orifice 80. Any ink 45 leaking from the needle 75 and migrating through the interconnected chambers of body 202 is contained by the skin 205. The humidically isolated chamber formed within skin 205 lessens the rate at which the ink 45 loses water or other volatile fluid components. Thus. the needle orifice 80 remains moist when the needle is buried or parked within body 202, as shown in FIG. 14. In contrast with humidor 50, for humidor 200 the entire portion of body 202 acts as a needle sealing portion, rather than just the parking core 82. One advantage of this feature is that the axial alignment and parking location of needle 75 within humidor 200 need not be as precisely controlled as in humidor 50.

In the illustrated embodiment, the general shape of humidor 200 is cylindrical in nature, and symmetrical about both longitudinal and radial planes. It is apparent that the humidor 200 may have an outer configuration as illustrated for humidor 50, with a base portion, neck portion and head portion (not shown). In the illustrated embodiment, the body 202 and skin 205 are configured to define alignment recesses or notches 210 and 212, which project inwardly toward a center portion of body 202 from opposing needle entry and exit end surfaces 214, 216, respectively. It is also apparent that the designation of "entry and exit end surfaces" refers to the installation orientation of humidor 200, since given the illustrated symmetrical configuration, either end may serve as either the entry or exit end, as indicated by the numbering in FIG. 13. This symmetrical feature provides manufacturing advantages, such as ease of installation since either end may be mounted in the reservoir wall 46.

FIGS. 14 and 15 show one manner of installing the humidor 200 in reservoir 40. The skin outer surface 208 is bonded to portion of reservoir wall 45 defining the outlet port 48, by an adhesive material, bonding agent or glue, sonic bonding techniques, spin welding or other techniques known to those skilled in the art, indicated generally at 218. Thus, the bonding 218 serves as a linking mechanism for securing the humidor 200 in a fixed position for use with a translating needle 75 which may be inserted manually or through an automated actuating mechanism (not shown) of printer 20. FIG. 14 shows the needle 75 in a parked position, with the orifice 80 isolated from the outside environment within the humidically isolating body portion 202 of humidor 200. FIG. 15 shows the needle 75 positioned to deliver ink 45.

FIGS. 16 and 17 show a portion of an alternate ink transport system 220 constructed accordance with the present invention to link the ink tubing 42 and needle 75 with ink reservoir 40'. It is apparent that a similar linking system may be used to couple the tubing 42 to a printhead 30' (FIG. 10), but for simplicity only the coupling at the reservoir 40 is illustrated. Here, the humidor 200 is installed along a surface 222 of the needle mounting member or support 152, which may be secured to the printer chassis 22, or to the printhead carriage assembly 30. 30', as described above with respect to FIGS. 11 and 12. The skin outer surface 208 at the entry end 214 is bonded to surface 222 by an adhesive material, bonding agent or glue, sonic bonding techniques, spin welding or other techniques known to those skilled in the art, indicated generally at 224. The bonding 224 serves as a linking mechanism to secure humidor 200 in a fixed position to receive the needle 75 for use with a nearby translating reservoir 40'. The surface-mount installation scheme of FIGS. 16 and 17 differs from that of FIGS. 14 and 15, where the humidor 200 is secured around a portion of its radial circumference within the surface

of reservoir wall 46 which defines orifice 48.

As described above with respect to FIGS. 11 and 12, the resilient manner of mounting humidor 50 in the transport system 150 is provided using a biasing spring 155. In FIGS. 16 and 17, the humidor 200 also has a biasing portion which is advantageously provided by the resilient nature of the foam body 202. In FIG. 17, the humidor 200 is in a compressed position, with the needle orifice 80 extending into the ink 45 within the reservoir 40', which may be a replaceable cartridge. When empty, the cartridge 40' may be replaced by moving it away from the mounting support 152, which allows the resiliency of humidor 200 provided by the foam body 202 to expands the humidor length to cover the needle orifice 80. After removal of the cartridge 40', FIG. 16 shows the expanded humidor body 202 with the needle parked inside to isolate orifice 80.

When parked, the humidor 200 protects an operator from accidental injury through contact with the needle tip 78. Furthermore, spills are prevented because any ink within the needle 75 leaks into the closed environment provided by the humidor skin 205. By using a resilient material for skin 205, the hole through which the needle extends, as shown in FIGS. 15 and 17, is self sealing, as described above with respect to humidor 50, and the self formed needle channel 90 (see FIG. 9).

Advantageously, the components of the printer used to insert the needle 75 in the humidor 200 may be of lighter construction than those used with the totally elastomeric humidor 50. This has further advantages of yielding a lighter weight printer design and possibly a smaller configuration for printer 20. Additionally, the use of the resilient feature of the body 202 reduces the number of components required over that shown for the embodiment of FIGS. 11 and 12, that is, there is no need for the spring 155 or the collar 154.

While the transport systems illustrated show the reservoir being located remotely from the printhead, it is apparent that the reservoir may also be carried on the printhead and carriage assembly 30, without requiring tubing 42, so the needle 75 forms the main portion of the ink conduit between the reservoir and printhead. For example, in FIGS. 11-12 and 16-17, the support 152 could be replaced with either printhead 30 or 30', eliminating the need for tubing 42.

The humidor 200 may be manufactured in any manner known to those skilled in the art. For example, the foam core of body 202 could be formed first, and then coated with the elastomeric or plastic skin 205. Alternatively, the skin 205 could be formed first, and the foam or other resilient material of body 202 injected therein. It is apparent to those skilled in the art that other manners of constructing humidor 200 may also be suitably employed. For example, while the skin inner surface 206 preferably lies adjacent the body outer surface 204, it is apparent that supports (not shown) may be added, such as between the body 202 and skin 205. For instance, a disk of a material stiffer than the foam body, such as an absorbent or nonabsorbent cellulosic material, may be placed adjacent either or both ends 214, 215 of the humidor 200, encircling the conical recesses 210, 212. Alternatively, this stiffer material may be formed by thickening the skin in these regions, or by increasing the density of the body 202 in these areas. Such a stiffer supporting material may be advantageous in mounting the humidor 200 in system 201 or 220.

Methods of Operation

In operation, a method is also provided of sealing an ink needle used to transport ink between delivery points, such as from a reservoir 40, 40' to a printhead 30, 30' of inkjet printing mechanism, for instance, printer 20. The illustrated method includes the step of coupling humidor 50 adjacent the needle delivery point. For example, the delivery point of origin in the embodiment of FIGS. 2-8 is the reservoir 40, and the humidor 50 is installed in the reservoir port 48. The delivery point of origin in the embodiment of FIG. 10 is the reservoir 40', and the delivery point of receipt is the printhead 30, 30'. Coupling at the reservoir 40' is accomplished by installing humidor 50 in the mounting member 112, whereas coupling at the printhead 30' comprises installing the humidor 50 in mounting member 114.

In an inserting step, the needle tip 78 is inserted into cavity 70 (FIG. 6), through the sealing core 82, and into reservoir 40 or printhead 30 until the needle orifice 80 is positioned beyond the humidor exit surface 66. The cylindrical wall 74 of the humidor cavity 70 resiliently forms a seal along the trunk of needle 75. For the embodiment of FIG. 10, this inserting step also includes the intermediary step of piercing septa 105 and 110. That is, after piercing the humidor exit surface 66, the needle tip 78 is then forced through the septum 105 and into the reservoir 40', or through septum 110 before entering the printhead 30'.

In accordance with the needs of the printhead 30, 30', ink 45 is extracted from the reservoir and infused into the printhead. In the illustrated embodiments, the ink 45 travels from reservoir 40, 40' through the orifice 80, the hollow interior of needle 75, conduit 42, the hollow interior of an optional printhead needle 75, and the nozzles of the printhead 30, 30'. A portion of ink 45 may be expended in a conventional manner for nozzle cleaning and priming functions, with the ink being expelled into a spittoon portion of a conventional printhead service station (not shown). Preferably, the majority of the ink 45 is deposited by printhead 30, 30' as an image on the print medium lying within the print zone 25. This goal is easily accomplished, since the sealing of the parked needle 75 provided by hu-

midor 50 minimizes ink drying and degradation, which minimizes waste and preserves the ink for printing.

In a retracting step, the needle 75 is retracted from the reservoir 40, 40' or printhead 30, 30'. In a parking step, the needle 75 is parked in humidor 50 by stopping the retracting step when the orifice 80 is surrounded by the humidor sealing core 82, as shown in FIGS. 8 and 9. Preferably, the retracting step continues until the needle tip 78 is also surrounded by the humidor core 82. The humidor 50 closes upon channel 90 to seal and protect the needle from air and contaminants in the reservoir 40, 40' or printhead 30, 30'. In a reinsertion step, the needle 75 may be pushed through the sealing core 82, septa 105 and 110 if used, and back into the reservoir 40, 40' or printhead 30, 30'. This reinserting step may occur, for instance after a step of refilling the reservoir 40 with fresh ink 45, or after replacing reservoir 40' or printhead 30, 30'. During this reinsertion step, a new channel (not shown) may be formed by needle 75, with the original channel 90 being sealed by the humidor body 52.

Another method is also illustrated with respect to FIGS. 16-17 of sealing an ink needle used to transport ink between delivery points, such as from a reservoir 40, 40' to a printhead 30, 30' of inkjet printing mechanism, for instance, printer 20. In a coupling step, humidor 200 is coupled to support 46, 152 adjacent a delivery point. In a piercing step, the needle 75 pierces the humidor skin 205 at the entry end 214, the body 202, and the skin at the exit end 216 until the needle orifice 80 extends into the delivery point 40, 40' or 30, 30'. In a transporting step, ink is transported through the needle 75 after the piercing step. After completion of the transporting step, the needle is retracted from the delivery point through the skin at the exit end 216, and in a parking step, the needle is parked in the humidor 200 by stopping the retracting step when the orifice 80 is surrounded by the humidor isolating portion 202.

In the illustrated embodiment of the sealing method, the coupling step comprises coupling a humidor 200 having a body 202 with a resilient biasing property, so the step of piercing the skin 205 at the exit end 216 comprises compressing the humidor body 202 by relative movement together of the support 152 and the delivery point 40, 40' or 30, 30'. The retracting step then comprises separating the support 152 and the delivery point and using the resilient biasing property of the body to expand the body 202 to cover the needle orifice 80 (FIG. 16).

Another method is also illustrated with respect to FIGS. 11-12 and 16-17 of sealing an ink needle used to transport ink between delivery points, such as from a reservoir 40, 40' to a printhead 30, 30' of inkjet printing mechanism, for instance, printer 20. In a coupling step, a humidor sealing apparatus 50, 200 having a biasing portion 155, 202 is coupled to a support 152 adjacent a delivery point 40, 40' or 30, 30'. In an inserting step, the needle 75 is inserted through the humidor sealing apparatus 50, 200 by compressing the biasing portion 155, 202 through relative movement together of the support 152 and the delivery point 40, 40' or 30, 30' until the needle orifice 80 extends into the delivery point. In a transporting step, ink is transported through the inserted needle. After completion of the transporting step, the support and the delivery point are separated to retract the needle 75 from the delivery point. In a sealing step, the orifice 80 is sealed by expanding the biasing portion 155, 202 until the orifice is surrounded by the humidically isolating portion 82, 202.

Conclusion

A variety of advantages are realized using the humidor sealing apparatus 50, 200, as well as the ink transport systems and methods, illustrated herein. For instance, ink chemistry integrity is maintained, leakage is prevented, and operator safety is enhanced. Use of the sealing apparatuses and methods as illustrated herein facilitates the implementation of refillable ink transport systems with permanent printheads, which conserves environmental resources.

Claims

1. A sealing apparatus (50; 200) for sealing an orifice (80) of an ink needle (75) supported to transport ink (45) between delivery points (30, 40; 30', 40') in an ink jet printing mechanism (20), the sealing apparatus comprising a body (52; 202) with a humidically isolating portion (82; 205) having opposing entry and exit ends(62, 66; 214, 216), and a biasing portion (155; 202) that couples the isolating portion to a needle support (152) adjacent one of the delivery points to selectively seal and expose the needle orifice.

2. A sealing apparatus (50) for sealing an orifice (80) of an ink needle (75) used to transport ink (45) between delivery points (30, 40; 30', 40') in an ink jet printing mechanism (20), the sealing apparatus comprising a resilient body (52) having opposing entry and exit ends (62, 66), the body defining a needle receiving cavity (70) extending inwardly from the entry end (62) and terminating in a first wall (72), the body also defining a needle sealing portion (82) between the cavity first wall (72) and the exit end (66).

3. A sealing apparatus (200) for sealing an orifice (80) of an ink needle (75) used to transport ink (45) between delivery points (30, 40; 30', 40') in an ink jet printing mechanism (20), the sealing apparatus comprising a body (202) of a foamed ma-

terial surrounded by a skin (205) of a substantially moisture impervious material to define opposing needle entry and exit ends (214, 216) with a humidically isolating portion (202) therebetween.

4. A sealing apparatus (50) according to claim 1 wherein the body (52) is of an elastomeric material, and the biasing portion comprises a spring member (155).

5. A sealing apparatus (200) according to claim 1 wherein the body (202) is of a resilient porous material that serves as the biasing portion.

6. A sealing apparatus (50) according to claims 1, 2 or 4 wherein the body (52) is of a material that forms a pseudopod (88) to seal the needle orifice (80) when a portion of the needle (75) adjacent the orifice is surrounded by the body (52).

7. A sealing apparatus (200) according to claims 1, 3 or 5 wherein the humidically isolating portion comprises a skin (205) of an elastomeric material and a body (202) of a porous foamed material encased within the skin.

8. An ink jet printing mechanism (20) comprising a sealing apparatus (50; 200) according to any of the preceding claims, and further including:

a printhead carriage system which carries a printhead (30; 30') to selectively deposit ink on a print medium;

a reservoir (40; 40') for storing a supply of ink (45); and

an ink transport system (50, 75, 42; 100, 150, 201, 220) which conveys ink from the reservoir to the printhead, the system including at least one hollow ink needle (75) having an orifice (80), with the sealing apparatus supported adjacent one of the delivery points (30, 40; 30', 40') to selectively seal and expose the needle orifice (80) to join the ink needle (75) with either the reservoir (40; 40') or the printhead (30; 30').

9. A method of sealing an orifice (80) of a hollow ink needle (75) used to transport ink (45) between delivery points (30, 40; 30', 40') in an inkjet printing mechanism (20), comprising the steps of:

coupling a humidor (50; 200) to a support adjacent (46; 102; 106; 152) a delivery point (30, 40; 30', 40'), the humidor comprising a body (52; 202) that defines opposing needle entry and exit ends (62, 66; 214, 216), with the body of a material that defines a humidically isolating portion (82; 205) between the entry and exit ends;

inserting the needle (75) into the humidor (50; 200) and through the entry end (62; 214), the humidically isolating portion (82; 205), and the exit end (64; 216) until the needle orifice (80) extends into the delivery point (30, 40; 30', 40');

retracting the needle (75) from the delivery point (30, 40; 30', 40'); and

parking the needle (75) in the humidor (50; 200) by stopping the retracting step when the orifice (80) is surrounded by the body material (52; 205) of the humidically isolating portion of the humidor.

10. A method according to claim 9, wherein:

the humidor further includes a biasing portion (155; 202) that couples the isolating portion (82; 205) to a needle support (46; 102; 106; 152) adjacent one of the delivery points (30, 40; 30', 40');

the inserting step comprises compressing the biasing portion (155; 202) of the humidor (50; 200);

the method further includes the step of expanding the biasing portion (155; 202) of the humidor (50; 200) during the retracting step.

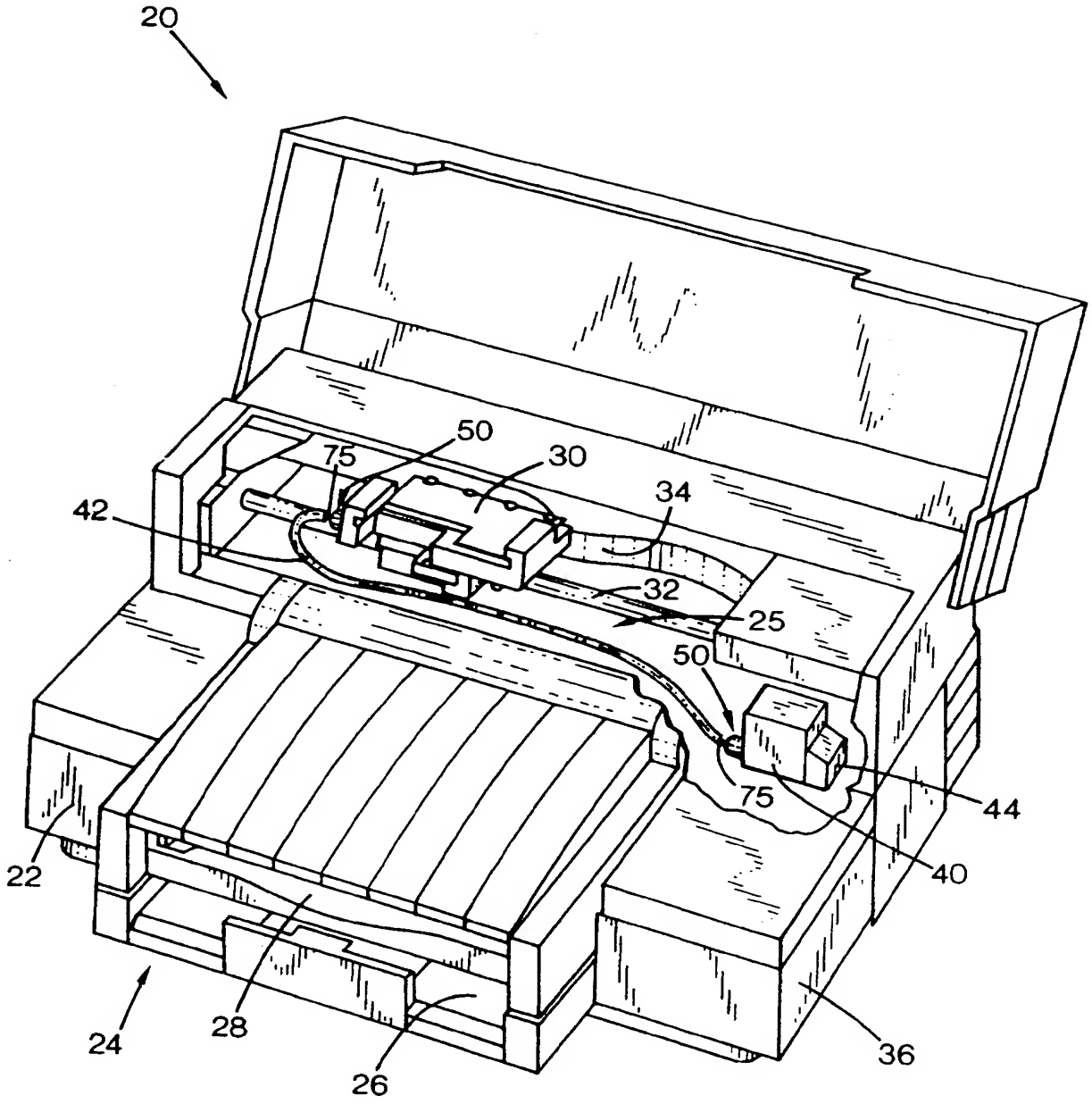


FIG. 1

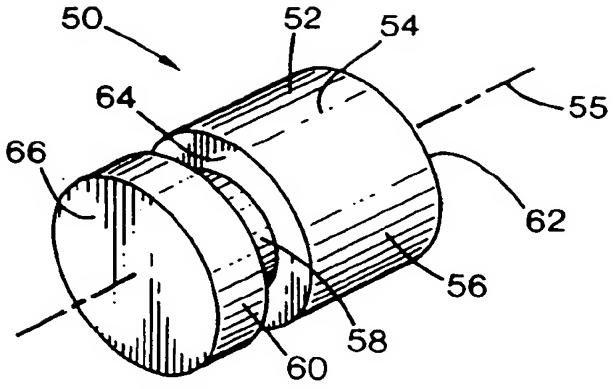


FIG. 2

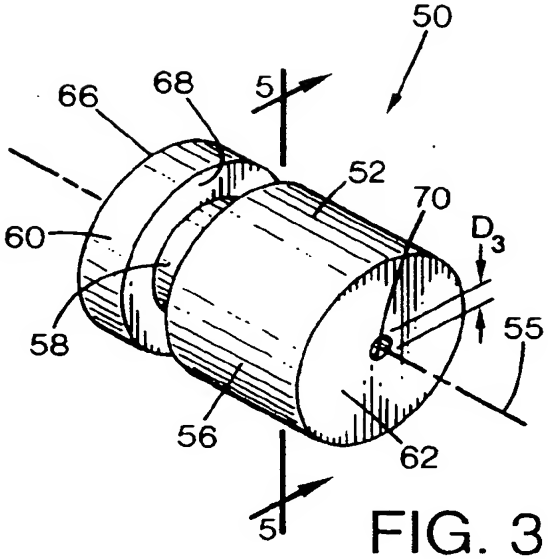


FIG. 3

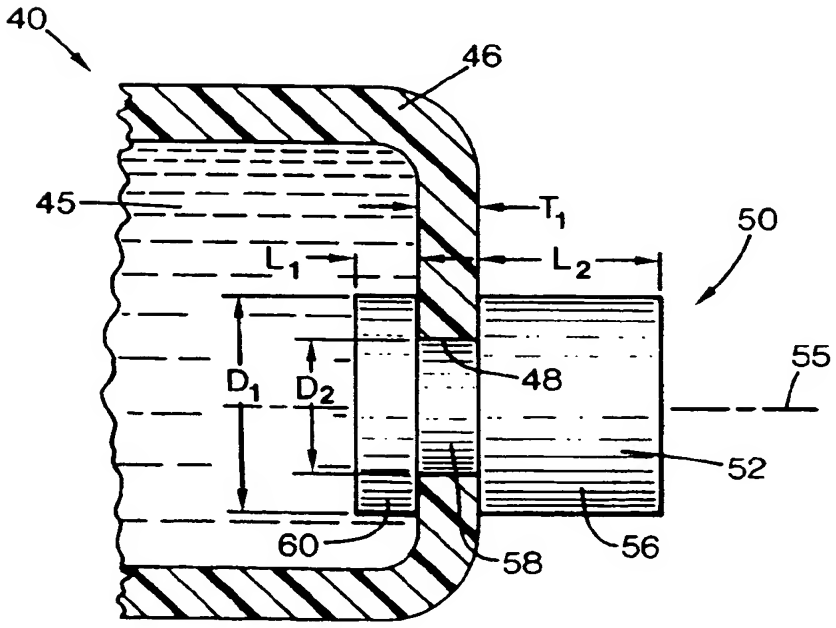


FIG. 4

FIG. 5

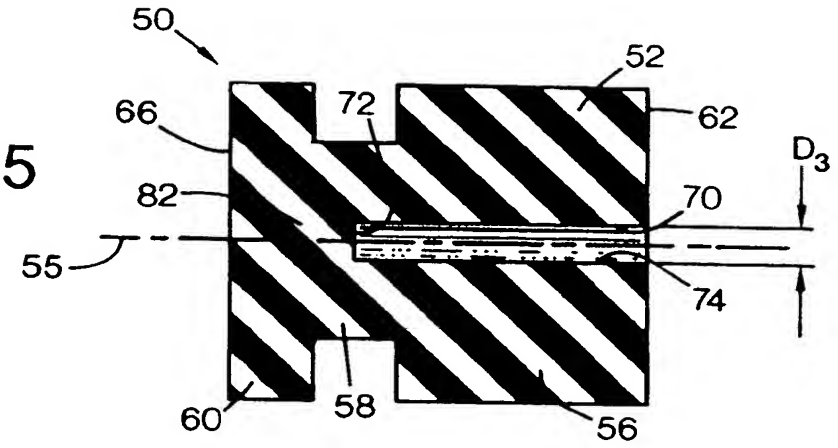


FIG. 6

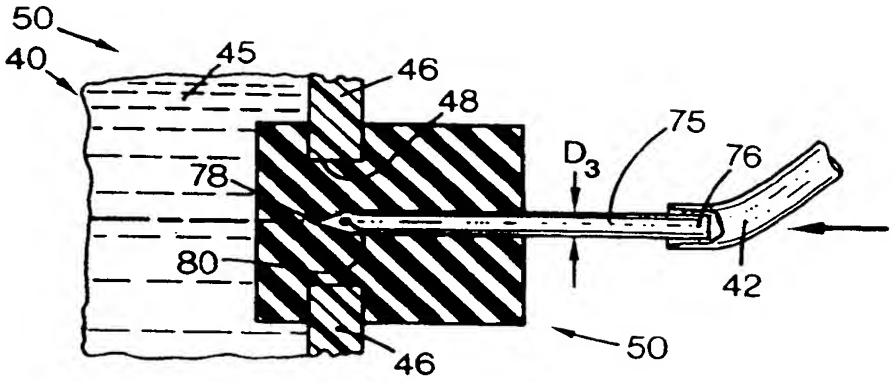


FIG. 7

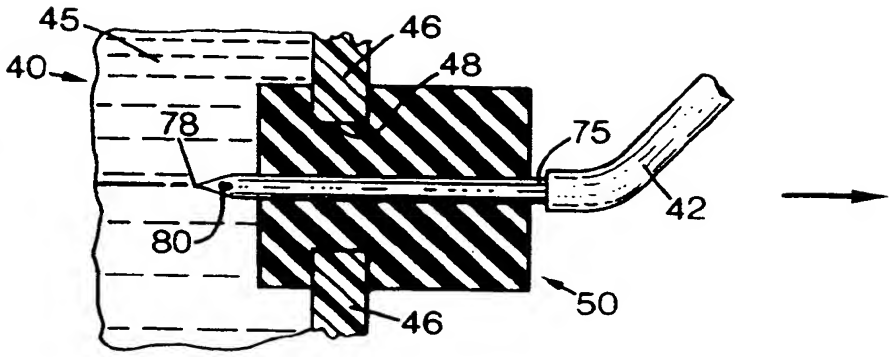
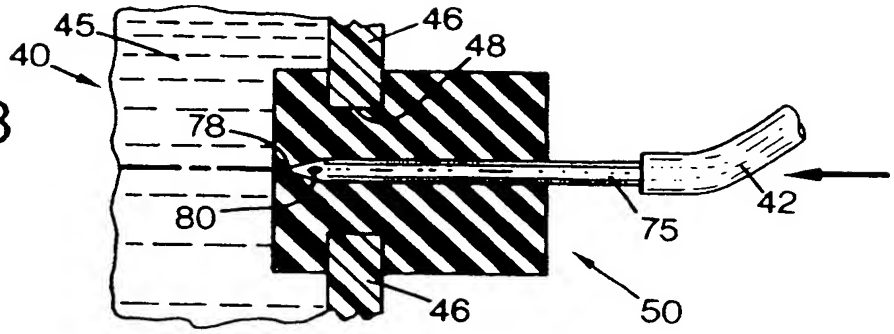


FIG. 8



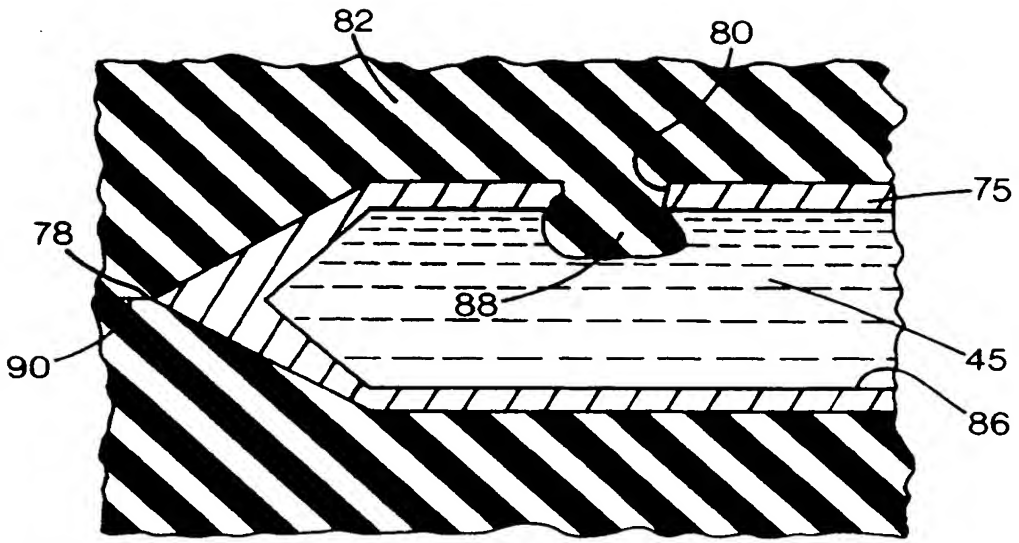


FIG. 9

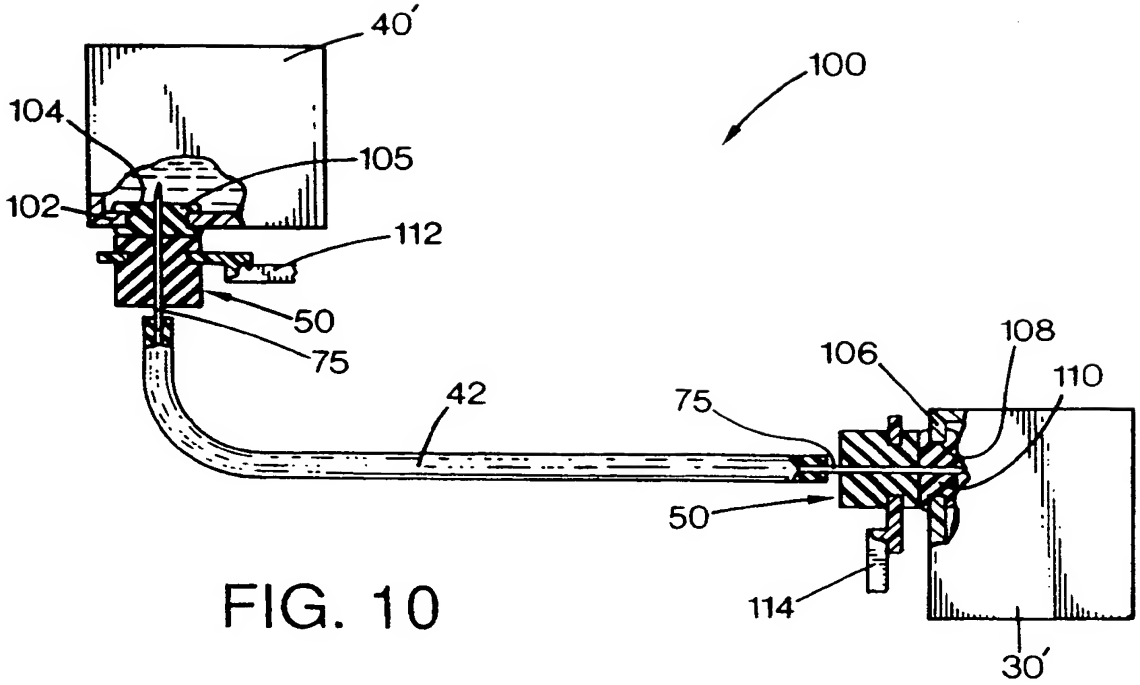


FIG. 10

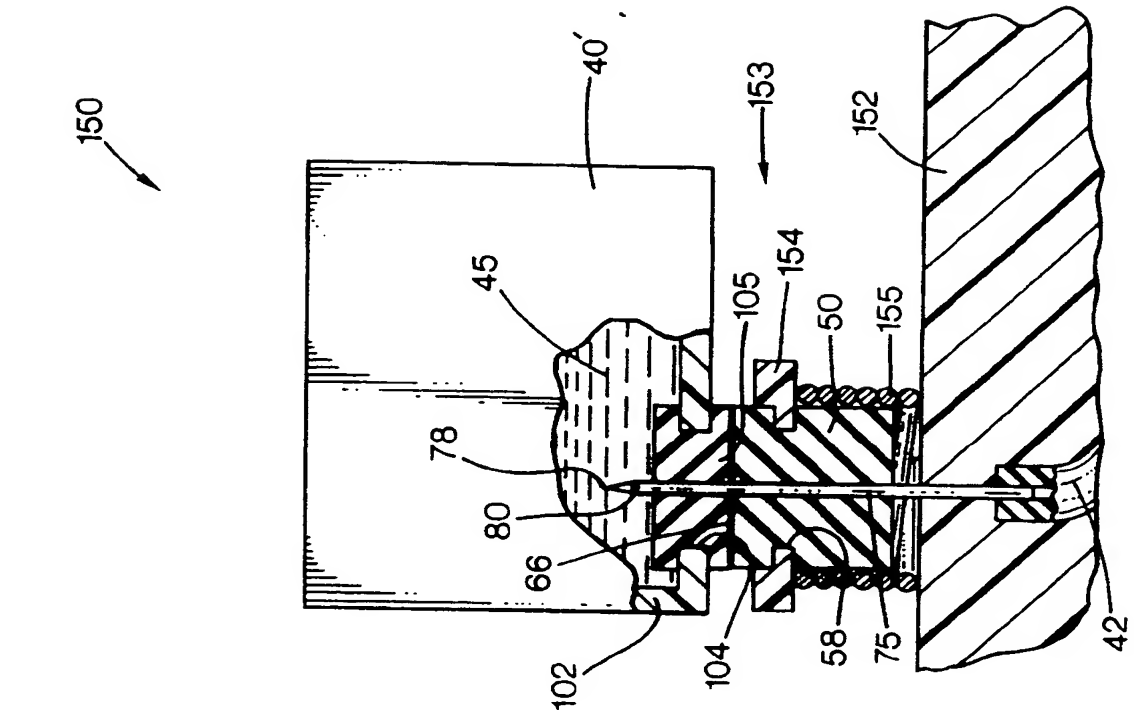

150
40'
153
152
45
105
154
50
155
78
80
66
102
104
58
75
42

FIG. 12

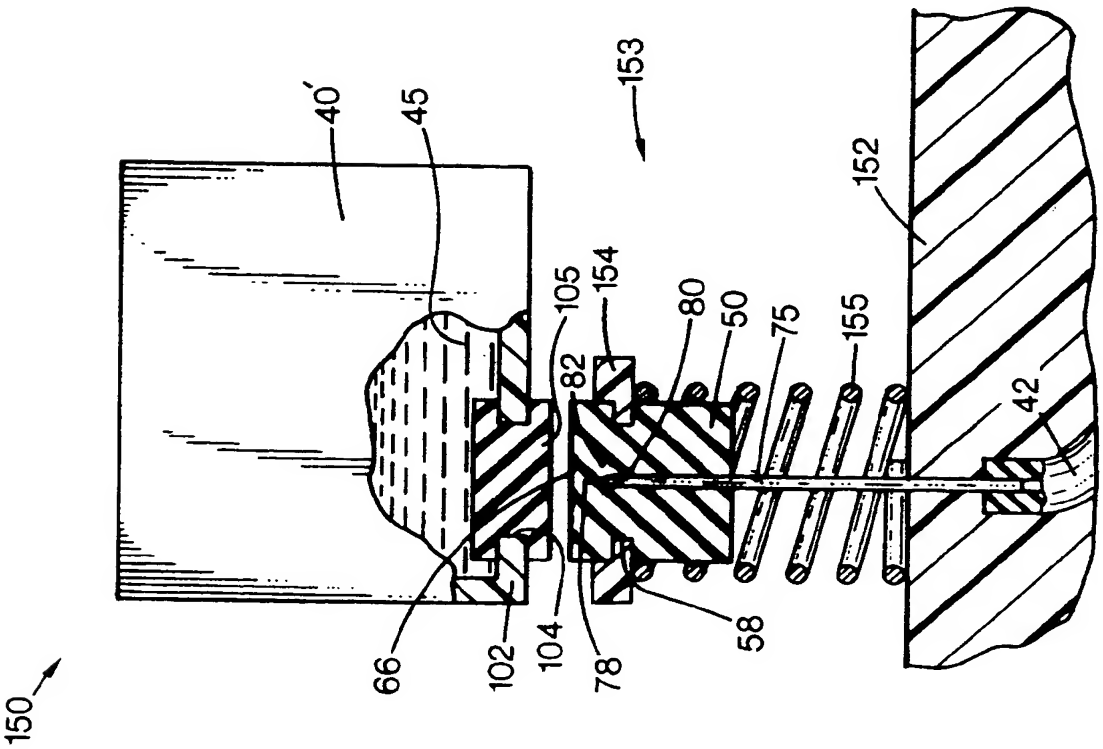
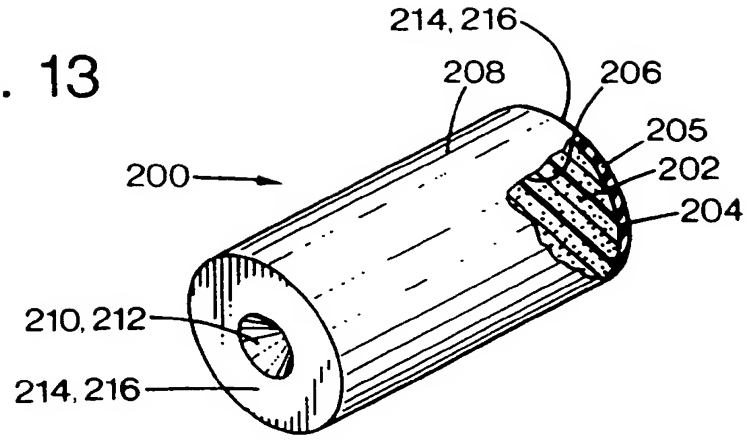

150
40'
45
153
152
105
154
80
50
75
155
82
42
66
102
104
78
58

FIG. 11

FIG. 13



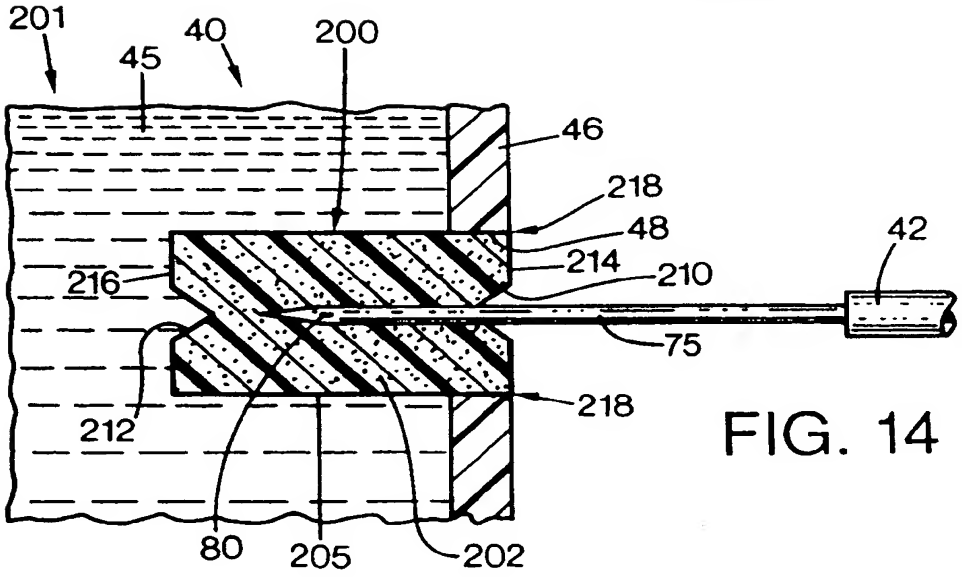
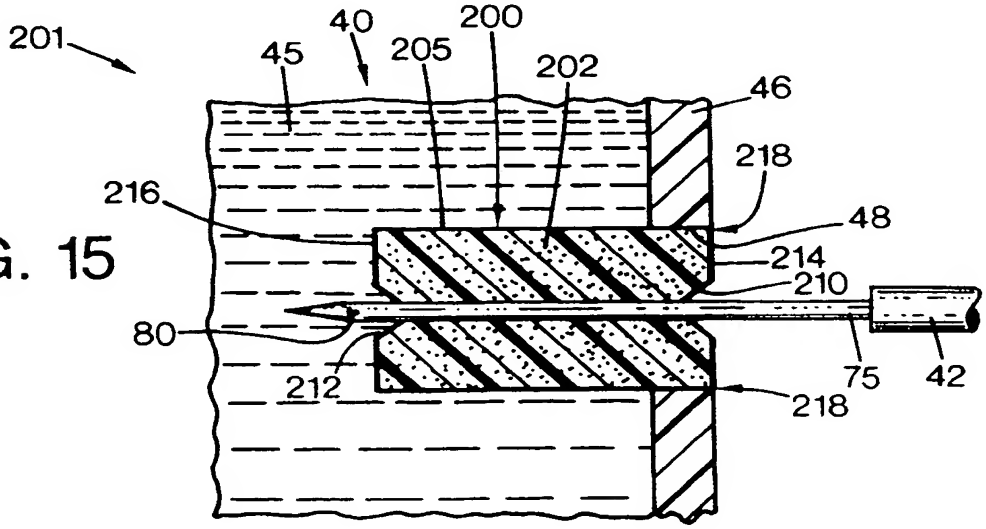


FIG. 14

FIG. 15



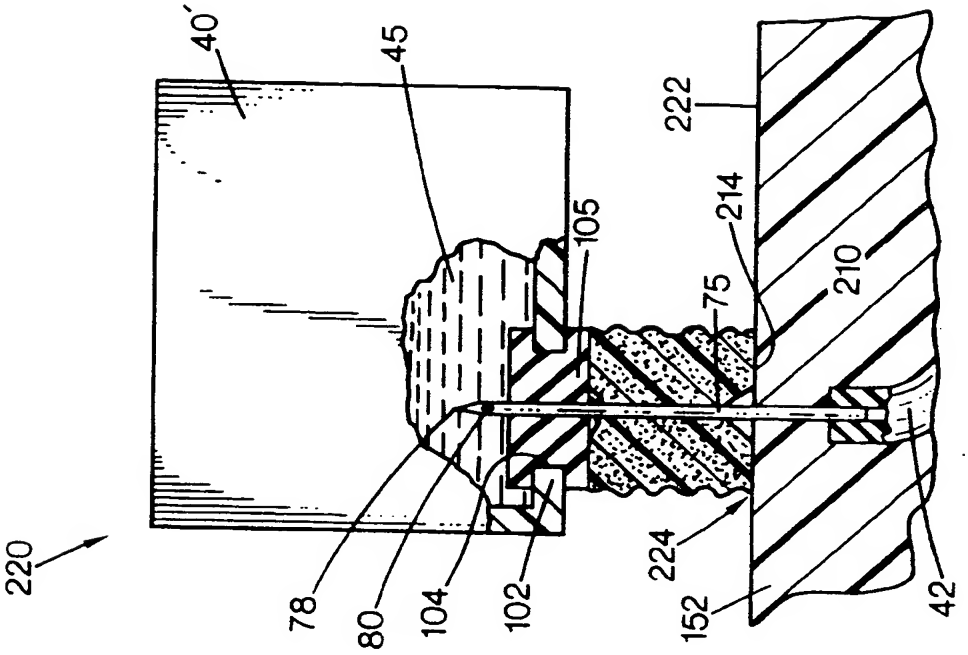


FIG. 17

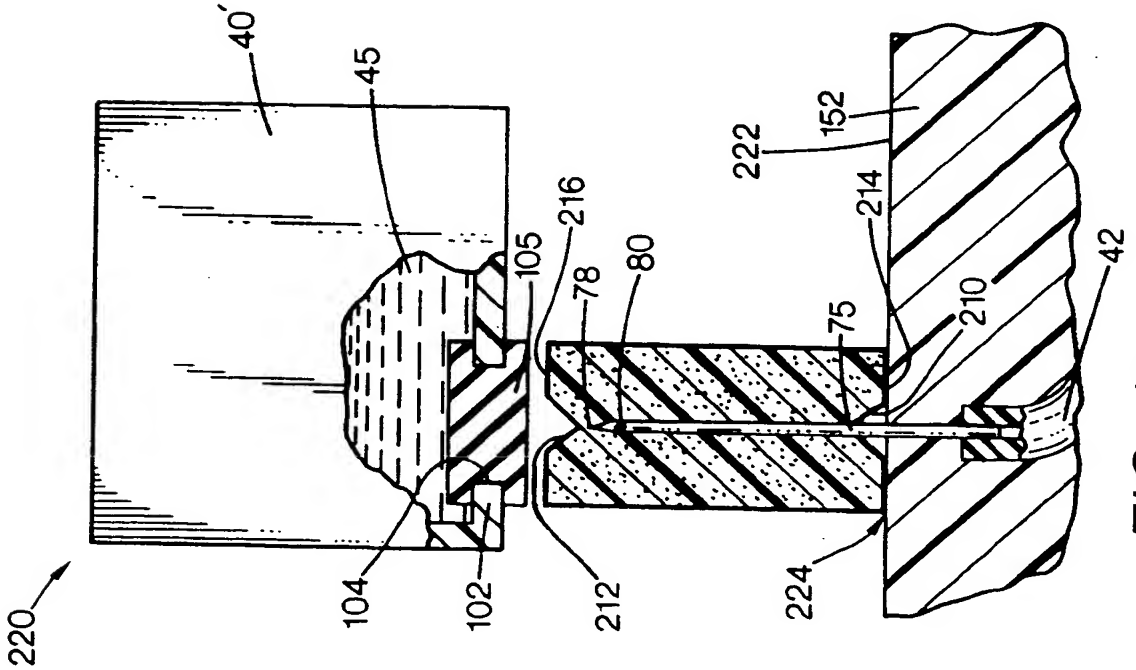


FIG. 16

FIG. 18A
PRIOR ART

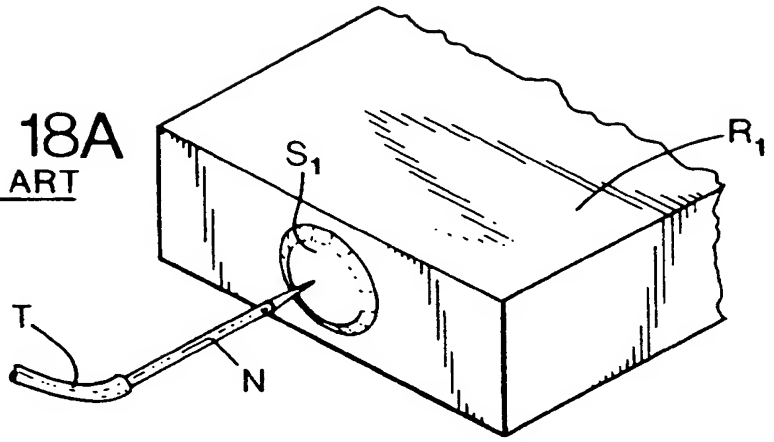
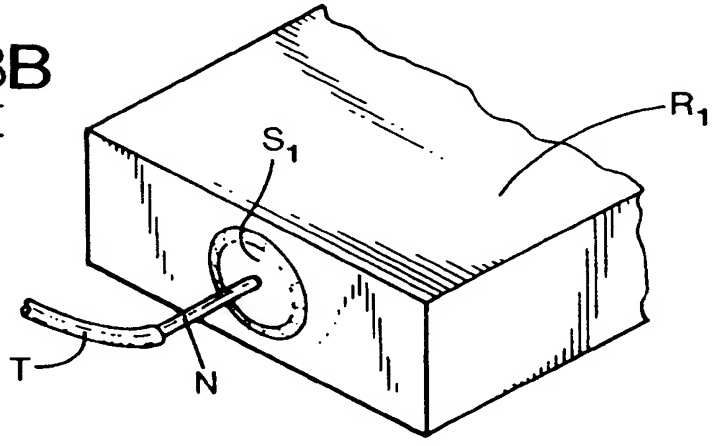


FIG. 18B
PRIOR ART



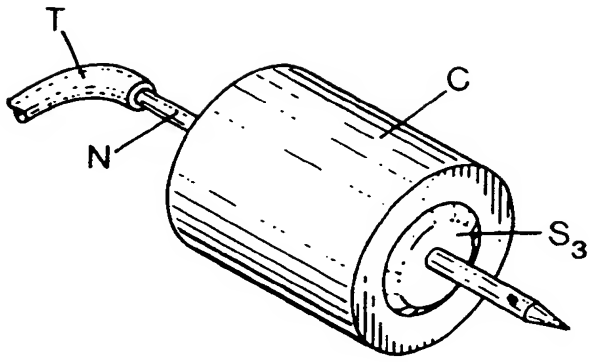


FIG. 19A
PRIOR ART

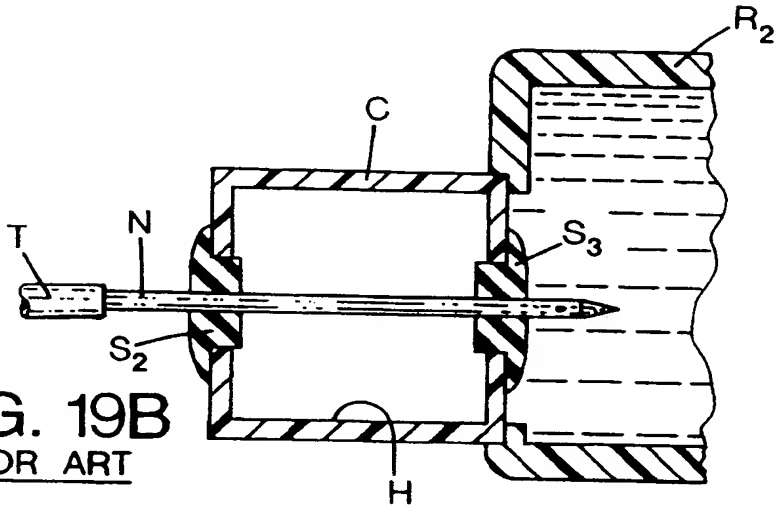


FIG. 19B
PRIOR ART

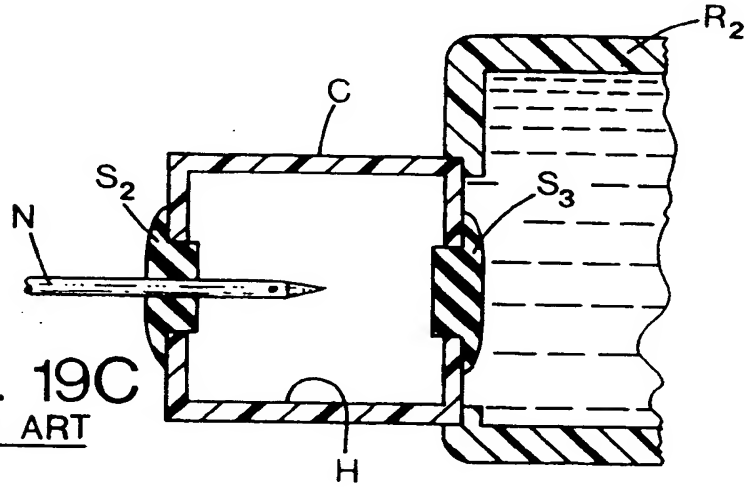


FIG. 19C
PRIOR ART

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European Patent Office
Office européen des brevets

(11) EP 0 676 293 A3

(12) EUROPEAN PATENT APPLICATION

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(43) Date of publication A2:
11.10.1995 Bulletin 1995/41

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(51) Int Cl.[6]: **B41J 2/175**

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(54) Ink jet needle humidor sealing system

(57) A sealing apparatus or humidor (50; 200) selectively seals an orifice (80) of a hollow ink needle (75) used to transport ink (45) from a reservoir (40; 40') to a printhead (30; 30') of an inkjet printing mechanism (20). The humidor (50) has a resilient elastomeric body (52) that forms a needle parking core (82; 202) where the body (52) extrudes into the needle orifice (80) to form a pseudopod plug (88) that seals the orifice (80). Alternatively, the humidor body (202) is a foam material surrounded by a substantially moisture impervious skin (205) that defines a humidically isolating parking core. Inserting the needle (75) through the humidor (50; 200) pierces the body (52, 202) to either extract ink (45) from the reservoir (40; 40') or infuse ink (45) into the printhead (30; 30'). During refilling, or replacement of the reservoir or printhead (40,40'; 30,30'), the needle (75) is retracted into the humidor (50; 200) until the orifice (80) is surrounded by the parking core (82; 202). The humidor body (52; 202) humidically isolates the needle orifice (80). which virtually eliminates ink spills, drying or contamination of the ink (45) within the needle (75), and prevents operator injury by the needle tip (78).

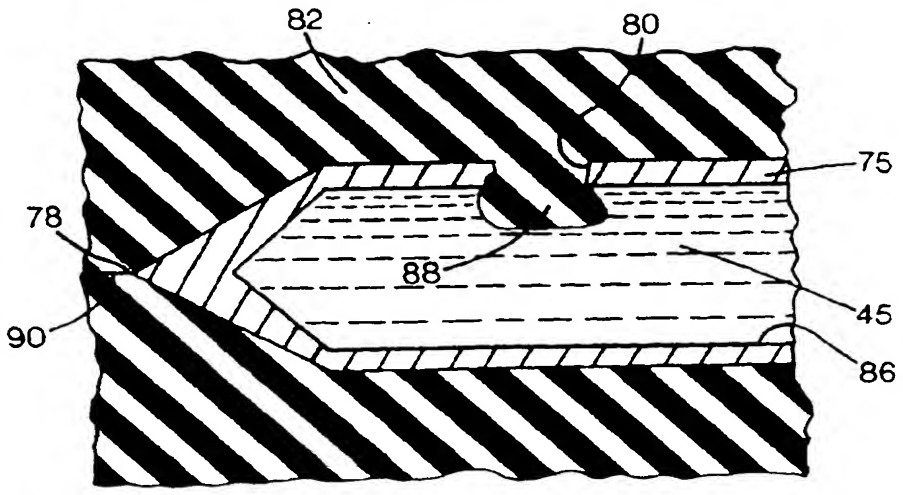

FIG. 9

EP 0 676 293 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 30 2152

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X A	DE 34 01 071 A (SIEMENS AG) 25 July 1985 * page 6, line 3 - page 9, line 24; figures 1-4 *	1-4,8-10 5-7	B41J2/175
A	PATENT ABSTRACTS OF JAPAN vol. 013, no. 380 (M-863), 23 August 1989 & JP 01 133750 A (SEIKO EPSON CORP), 25 May 1989, * abstract *	1-3,8,9	
A	DE 41 39 731 A (INNO-PRINT) 9 June 1993 * column 2, line 2 - line 59; figures 1-5 *	1-4,8-10	
A	US 4 867 207 A (CRAWFORD THOMAS) 19 September 1989 * column 6, line 57 - column 8, line 42; figures 5,6A-6C *	1-3,8,9	
A	PATENT ABSTRACTS OF JAPAN vol. 012, no. 416 (M-759), 4 November 1988 & JP 63 153146 A (RICOH CO LTD), 25 June 1988, * abstract *		TECHNICAL FIELDS SEARCHED (Int.Cl.6) B41J
A	EP 0 567 308 A (LEXMARK INT INC) 27 October 1993		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	5 August 1997	Adam, E

EPO FORM 1503 03.82 (P04C01)

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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